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REVISION OF THE MAP OF LAKE AGASSIZ

WARREN UPHAM
Minnesota Historical Society, St. Paul, Minnesota

After the lapse of twenty years since the completion of my official service on the geological surveys of Minnesota and the United States, it is not surprising that changes and additions have been made, and that others are needed, on maps of the glacial and modified drift formations and the successive shorelines of the glacial Lake Agassiz, as these were published in the reports of my work from 1879 to 1895. Therefore the recent *Bulletin 12* of the Minnesota Geological Survey,[1] entitled "Surface Formations and Agricultural Conditions of Northwestern Minnesota," by Mr. Frank Leverett, of the United States Geological Survey, has much interested me.

One of the most noteworthy additions here made to our knowledge consists in the more accurate description and mapping of the somewhat elevated large tract between Red Lake and the Lake of the Woods, which was named by me Beltrami Island.[2] My original description and map of this island were doubted and questioned by Professor James E. Todd in 1899;[3] and they have now been shown by Mr. Leverett, with more definite surveys, including information of exact altitudes throughout this area, to need important revision.

A line surveyed about the year 1892 for the Duluth & Winnipeg Railroad Company took a straight northwesterly course from the most northeastern part of the shore of Red Lake to the most southwestern part of the Lake of the Woods, at the present station of Warroad. Through a distance of 18 miles next northward from Red Lake this survey traversed a continuous swamp, called on the profile "tamarack and spruce swamp," which includes the divide between the basins of this lake and the Rainy River. The depth of the mud and water throughout the swamp was from 5 to 15 ft., being mostly between 7 and 10 ft.; and in many places the hard bottom was noted as gravel and sand. The highest part of the surface of the bog or swamp on this line, forming the water divide, some 5 to 6 miles north of Red Lake, has an elevation of 1,197 ft. above the sea, being 21 ft. above the lake. Westward from this lowest part of the divide on the north side of the basin of Red Lake and the Red Lake River lies the area of Beltrami Island, of which the northeast margin was crossed by this railroad survey, rising there to a height of 1,283 ft., or 107 ft. above Red Lake and 86 ft. above the eastern base of the island.

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[1] This report, 78 pages, with 8 plates (a folded map and views from photographs) and 14 figures in the text (maps and diagrams), was published by the University of Minnesota in February, 1915, under Professor William H. Emmons, director, in co-operation with the United States Geological Survey. It includes also a chapter on "Climatic Conditions in Minnesota," by U. G. Purssell, United States weather observer in Minneapolis.

[2] *Am. Geologist*, XI (June, 1893), 423–25; "The Glacial Lake Agassiz," 1896, *U.S. Geol. Survey Mon. XXV*, 304–06, with mapping on Plates III, X, etc.

[3] *Geology of Minnesota*, IV, 149–50.

The profile of the surveyed line shows a well-defined beach of Lake Agassiz at 1,215 ft., this being the highest recognizable beach ridge crossed by the survey. On the descent toward the Lake of the Woods the profile crosses a succession of ten lower beaches of the great glacial lake, their altitudes above the sea being 1,196, 1,172, 1,156, 1,143, 1,127, 1,116, 1,106, 1,099, 1,093, and 1,087 ft.[1]

These beach ridges are clearly indicated by the profile, but none are shown at higher levels. My conclusion from the profile record, therefore, was that the series comprises the highest shore and the successively lower shores of Lake Agassiz. The higher part of the tract northwest of Red Lake was accordingly called an island of that glacial lake, and was named, like the county in which it mostly lies, for the exiled Italian author, Costantino Beltrami, who in 1823 was one of the earliest white men to traverse and describe this region. He was preceded only by the Canadian geographer, David Thompson, in 1798.

An elaborate map of this area, from Red Lake north to Rainy River and the Lake of the Woods, with contour lines at intervals of 10 ft., accompanies a report published in 1909,[2] entitled "Drainage Survey of Certain Lands in Minnesota." These lands, ceded by the Chippewas, were surveyed in 1906–8, for the United States Geological Survey, under direction of W. H. Herron, geographer. On the large map of this report the contour of 1,200 ft. above the sea incloses a tract of 1,167 square miles, its most southern point being 4 miles north of the mouth of Red Lake, and its most nothern point 2 miles south of Roosevelt, on the Canadian Northern Railway, and about 9 miles south of Muskeg Bay, the most southwestern part of the Lake of the Woods. This large tract, nearly flat or somewhat undulating, rising to a maximum elevation of 1,310 ft., would be an island if the conditions that produced Lake Agassiz were now restored with the lake level at 1,200 ft.

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[1] Notes of this profile were published in *Geology of Minnesota*, IV (1899), 136–37.

[2] 61st Cong., 1st sess., *H. R. Doc. No. 27*, 40 pages.

Beltrami Island, as thus outlined, however, differs much from its mapping in the Lake Agassiz monograph; for on the west it falls short, by 12 miles, from reaching to Thief Lake, which had been included in the tentative original map of the island area. But the beaches bordering the island have been only partially mapped; and when this work shall be completed by leveling they will show an ascent northward, or almost northeastward, like the other mapped shores of the old glacial lake. Appealing to the mapped gradients of the Herman shorelines from the south end of Lake Agassiz north to Maple Lake and eastward past the south side of Red Lake, Mr. Leverett well concludes that the highest Herman beach, if it is represented on Beltrami Island, must sweep with its northeastward ascent well-nigh above the entire island, touching only its highest ground, in Tp. 159, Rs. 35 and 36.

Even the second, third, and lower Herman beaches, mapped in succession at slightly lower lines to an entire number of seven on the west side of Lake Agassiz in southern Manitoba, may all be referable, as Professor Todd suggested, to water planes above the beaches at 1,215 and 1,196 ft. on the railway profile crossing the northeast edge of Beltrami Island. My original supposition that much of this island was above the highest level of Lake Agassiz has been needfully corrected by Mr. Leverett in this report.

Whether any of the Herman shores was marked on the island must depend on the position of the ice border in northwestern Minnesota when the glacial lake fell to its Norcross stage, which, like the Herman stage, and like the lower Tintah, Campbell, and McCauleyville stages, becomes subdivided in its extension northward before reaching the International Boundary at the west side of Lake Agassiz. In my examination and studies of these shorelines for the geological surveys of the United States and Canada, the whole series of seven Herman beaches was regarded as yet present so far north as on the boundary between North Dakota and Manitoba, 224 miles north of Lake Traverse; but the two upper Herman beaches were thought to cease before coming to the latitude of Gladstone and Neepawa, in Manitoba, 308 miles from Lake Traverse and the mouth of the glacial lake. On Valley River in Manitoba, between the Riding and Duck mountains, 150 miles north of the international boundary and 375 miles from Lake Traverse, all the Herman beaches had ceased, according to my tabulation and correlation of the notes of Mr. J. B. Tyrrell, of the Canadian Geological Survey; but the Norcross, Tintah, Campbell, and McCauleyville beaches seem to be represented there by his observations.[1]

The discrepancy between my estimates and those of Mr. Leverett for the place or height of the Herman beaches north of Red Lake comes partly from his better determination of the large easterly component in the direction of maximum uplift and present ascent of the ancient lake-levels, which in their continuation eastward of Maple Lake trends increasingly toward the northeast. In manuscript notes on a map kindly supplied to me, Mr. Leverett records a well-defined beach of Lake Agassiz, 1,297–1,300 ft. above the sea, on the Minnesota & International Railway about 4 miles northeast of Gemmell, or 25 miles east-southeast from the north part of Red Lake. This is the highest of the Herman series there, and its rate of ascent from the vicinity of Maple Lake justifies the belief that has been already stated concerning the occurrence of the Herman shorelines on the area of Beltrami Island.

It is to be noted further in this connection that the trend of the Late Glacial uplift of the land and consequent ascent of the old beaches, near Red Lake and the Rainy River, now found to be N. 35° E., carry the conspicuous Campbell beaches farther east than my mapping in the United States Geological Survey monograph. The incoming of settlers, with the construction of roads and railways and clearing away the forest in many places to open farms, now gives opportunity to trace the courses of the beaches through the country adjoining the Rainy River, where Mr. Leverett maps a finely developed shoreline, referred to the Campbell stage of Lake Agassiz, for the distance of about 40 miles, from near Roosevelt east-southeastward to Baldus, having the height along all this isobasic course of about 1,120 ft. above the sea. This altitude is as great as the highest of the Campbell beaches has on the eastern slope of Riding Mountain in Manitoba, which shows that the isobase of the land uplift there crossing the lake area runs about N. 55° W. In other words, the direction of maximum uplift is approximately N. 35° E.

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[1] *U.S. Geol. Survey Mon. XXV*, pp. 476–77.

With the light thus received, we may quite confidently correlate the series of eleven beach ridges noted by the profile on Beltrami Island and northward, from 1,215 to 1,087 ft., as representing the second Norcross, Tintah, and Campbell stages of Lake Agassiz, but with other subdivisions than were noted in my tabulation for the latitudes of Gladstone and Valley River, Manitoba.

The present report and its large detailed map of the surface formations of the northwest quarter of Minnesota, on the scale of 8 miles to an inch, are designed primarily to instruct and aid farmers, drainage engineers, road-builders, and others, for the development and utilization of the agricultural resources of this state.

Glacialists and other geologists will desire that Mr. Leverett present later, for the entire state of Minnesota, a more specific description and discussion, and additional maps, setting forth the successive borders of the waning ice-sheet, as shown by their moraines, with the corresponding stages of growth of Lake Agassiz, and treating fully of the erosion, transportation, and deposition of the various drift formations. Such maps will be much improved by insertion of contour lines, and by notations of altitudes of lakes, rivers, railway stations, etc., whereby the form of the land surface and the elevation above the sea will be shown, giving information that seems indispensable for a definite understanding of the drift, loess, and glacial lakes.